Spring Pole Drilling.

ANTHONY HOWELLS.

READ AT COLUMBUS MEETING.

Drilling for coal is not a very ancient practice, at least not to my knowledge, and especially so in the State of Ohio; and when I say the State of Ohio, I think it includes all of the United States, because drilling for coal, without a doubt, was first brought to use in the State of Ohio.

Who the inventor was (if indeed it can properly be called an invention) no one in my opinion can tell, and if it was necessary to find out, I think we would arrive as near to the truth as to who was the author of that finest of poems — The Beautiful Snow. However, we are certain of one thing that, whoever the genius was, necessity was the motive which spurred him on to the accomplishment. Sanko Panzo said, "God bless the man who first invented sleep," we coal operators should say, God bless the man who first invented spring pole drilling.

I presume that drilling for coal was first practiced in the Mahoning Valley, and about the years 1848 to 1850, because previous to that time, every coal mine opened out in that valley, (and I may safely say in the State) was made on the crop of the coal, the same as is now done in opening mines that are level free or above water-level.

Up to 1850 there had been only four coal mines, I believe, opened out in the Mahoning Valley, for the purpose of shipping coal, two by William Philpot which proved to be small basins, one by David Tod which proved to be a large basin, and one by Crawford & Murry which also was quite extensive, all of which were opened on the crop of the coal, and when the coal took a dip and got under water, the mode of discharging the water from the working was with the water-tank, hand-pump and the mule-pump.

The supposition at the time was that the seam of coal was persistent and regular, as the case is in general with all seams of coal; however, this was soon found to be a very delusive delusion, as cut-offs were encountered, the coal giving out, and it soon became an accepted fact, that the coal was formed in pots or basins, and when no longer to be seen on the surface, a new method had to be contrived to find its location, and here then is the starting point of spring pole drilling, and the pole is still to be seen, bobbing up and down, as it was thirty-five to forty years ago.

In early times the method of drilling was, to first determine the spot to drill, then dig a well to the rock, then insert a wooden pipe (made of two inch planks) in the well, then put up the pole, which is about thirty-six feet in length and of the toughest ash or maple wood that can be got, the butt end of the pole is left on the ground with two stakes, one on each side, drove deep to the ground (wedge fashion), so as to keep the pole firm in the proper position. The small end is elevated about twelve feet immediately over where the hole is to be, and sustained in that position by two stout, wooden forks, each placed so as to brace against the other, and about fifteen feet back from the small end of the pole, thus giving the required spring to raise up the rods each time the driller pushes them down.

In early times the pole used was of much less size than those now in use, for the reason that all the tools, rods, etc., were of much less weight. For instance, all the iron that was then used was the bit and sinking rod, for the balance of the depth necessary to go, a three-fourths or one inch rope was used; and indeed the same is now in use when drilling for water, and where no rock is encountered.

But, before long it was found that this mode of drilling would not accomplish the desired results, because sand, gravel or water was found, so that the well could not be sunk to the rock, hence the wooden pipe could not be inserted, but when necessity demands, something will always turn up, and in this case the gas-pipe was the new factor, and which is now in general use where drilling is practiced. Hence when experience proved that coal was of considerable depth in the ground, the rope gave way to the iron rod, and which is now universally used in drilling for coal.

A set of drilling tools consists of from four to six bits made to drill a hole from two and one-half to two and three-quarter inches in diameter with a sinking-rod (the one connected to the bit) made of one and one-quarter bound iron, about fifty feet of one and one eighth rods, about fifty feet one-inch rods and about fifty feet seven-eighth rods. Length of rods generally being about fourteen feet, with one about eight, one about six, one about four, and one about two feet in length, so as to make the desired length of rods as the hole progresses in depth. It requires also to have two handles, each fastened to the rods with a hook-bolt and forming a cross. So if necessary four men can work at the same time, also heavy sledge hammer, one or two hand hammers, ax, hatchet, wrenches of different kinds, a chain with a hook at one end, being the one that is attached to the rods, the upper rod always having a ring (swivel fashion) fastened to it, a derrick is also needed, made of three poles about twenty-five feet long with a pulley attached to derrick, then a one-inch rope with a hook at one end, the other end running down to a windlass.

Sometimes formed in two legs of the derrick, this being the power used to hoist and lower the rods in and out of the hole, a sand-pump is also necessary, which is made of heavy tin or sheet-iron, and of the size so as to work freely in the hole and from three to four feet in length to suit the fancy of the driller, a bumper is also necessary which is made of the butt of a tree twenty to twenty-four inches in diameter and from three to four feet in length and of the knottiest and toughest wood that can be got. I might mention right here, that of late years the use of steam in drilling is coming more and more into use and that it is only a matter of a short time that hand-drilling will be a thing of the past, but the paraphernalia is about the same, but two men with steam will accomplish more, and with much less labor than four men will in hand-drilling.

Having the tools pretty well collected together, the first thing to do is to start a hole with a dirt auger, then insert a three-inch gas pipe. Hang up the bumper to the pole, then strike the pipe with all our might. After driving the pipe in this fashion, as far as it can be easily drove, the bumper is laid aside, and the rods are put into the hole, then drilling is done as far down below the pipe as is possible to do, and that depending on the nature of the ground to go through, then again the bumper is required, and so on, rods and bumper alternating, and as each pipe goes down another one is screwed on until rock or some other solid substance is reached. How far we have to drive pipe can not well be told, as drift deposits vary very much in a short distance, as much as 100 feet in less distance than 300 feet, the deepest pipe driving I am conversant with is 140 feet, and the first solid material met was coal to the thicknes of four and one-half feet; but, of course, worthless in having no roof. In most places where much thickness of drift deposit is met with, it gives more or less trouble to drive the pipe, and at times impossible to do so, for the reason of striking stray pieces of limestone or boulders, and when met, several ways are resorted to too overcome the difficulty—one way, to put dynamite down the hole to burst the rock; another, to drill through the rock, and insert a two-inch inside the three-inch gas pipe; another, and generally the least expensive, pull up the pipe and start a new hole a few feet from the first one. If, however, the three-inch pipe has been drove fifty to sixty feet, and from any cause it becomes impossible to drive it deeper, the best and cheapest method is to insert a two-inch pipe, though not desirable if it can be avoided. Neither can we tell how deep we have to go to strike coal or bottom rock, especially so in a new territory; and indeed, even when coal is found only 500 or 600 feet distance, for the reason of the unequal elevation of the coal, or the hills and valleys forming the coal basin differing as much as sixty feet, and this being one good reason that often coal is not found where there

is plenty of it. I may also say right here that there are hardly two drill holes exactly like; all differ in the material gone through, and in the thickness of the stratum overlying the coal. Like the human face, similar, but no two alike. For instance, will take the next stratum to the coal, commonly called gray rock. This I have known to vary (even when coal was found) from four to thirty-four feet. It differs also in its composition and color; sometimes very dark; sometimes very light; sometimes coarse grain and tender, and sometimes fine grain and very hard. The one most natural to insure coal is the light gray, and from sixteen to twenty-four feet in thickness; and if any thickness of black slate is found beneath the gray rock, it is a sure sign of coal beneath; but if coal is found immediately beneath a hard, fine grain rock, it is a sure sign that some trouble or cut-off is near by; and if an unusual thickness of coal is found—say seven feet or over, it is a sure warning of some trouble, because the unnatural thickness is caused by an unnatural process; hence, if I may use the figure, the coal comes to an unnatural end, to the disgust and grief of the operator. As to the time it requires to drill a hole, depends on many contingencies. For instance, the depth required, the hardness of the material to go through, and the skill of the driller; but it is safe to say that a practical driller can earn fair wages in drilling not to exceed 200 feet, at from fifty-five to sixty cents per foot; and I wish to state right here that all references are made to what is commonly known as the No. 1, or the Brier Hill, or Massillon coal. Neither is coal found in every hole. I think I can safely say that not one hole in five has been productive; and if all the blank holes were added together, either in feet or in money spent, the length would be many miles, and the expense enormous.

Now, it may be asked if it requires experience to know where to drill and to find coal. The answer may be made yes and no, because sometimes the tenderfeet (a term used in Colorado and other Western States for the inexperienced) have stumbled on some of the best basins of coal that have ever been found; while the same class of people have also spent much unnecessary money; hence, the old proverb is applicable, "the experience is gained, but the money is gone." In my opinion, to be successful in finding coal, with only the necessary expenditure of money, a person should have experience as a miner, as well as a driller, with a perfect knowledge of the character of the strata to be drilled through; also grit and a positive self-reliance in his own judgment; he requires experience, because of the many conditions under which coal is found; thus giving him advantage when coal is found in one hole to properly trace the basin with as few holes as is practical, until the proper average is found to justify him in opening his mine, and this will be when he has found from twenty-five to sixty acres of coal of the proper thickness, the acreage depending on the

probable expenditure required to open up the mine, which will vary from $25,000 to $60,000. He also requires knowledge of the material overlying the coal, so that he can tell whether it is above or below the coal; thus stopping the useless expenditure of money. He also requires grit, so that when he encounters a very hard rock, and is doubtful of its location, to work away, even when only making a few inches per day, as the case often is, and in the end his grit is repaid by finding a basin of coal, while in many instances a hole of that nature has been abandoned and a basin of coal has been lost. So the old adage can be applied here, "a faint heart never wins a fortune nor fair lady." For the want of experience and knowledge (but not for the want of grit in this instance) I have known a drill hole to be called blank, and the territory almost condemned, when, after opening up the mine, the drill hole was found, and had penetrated through five feet of coal; and, indeed, not one instance but several; but with the above mentioned qualifications a person is not apt to miss coal where it is to be found, nor to expend unnecessary money in drilling below where the coal ought to be, and also make him perfectly satisfied of the thickness of the coal gone through, and is able, if necessary, to warrantee the fact. I may also add, that drilling for coal is of the most exciting, encouraging and discouraging nature.

When drilling in a new territory, and the hole down in the gray rock, and all indications look well, and visions of profits within his grasp, the average mind can not help but become somewhat excited; and when coal is touched the excitement becomes greater, until the thickness of the coal is ascertained. If of good thickness, four to five feet, he feels much encouraged, and becomes the hero of a well fought and won battle. He then starts another hole without delay, drilling down to where the coal should be, but none is found; he keeps at it another day, hoping something may turn up; but the end is he hangs his lip and looks dejected; but agatn takes courage and starts a new hole, and coal is again struck. Now the excitement and encouragement is again on top; but when the drill penetrates a few inches further, the coal is gone; now, if coal men were in the habit of swearing, this is the time that this accomplishment would be severely indulged in, but not addicted to that habit, they become philosophers, and say, we will try it again; and as the drilling progresses the excitement is sometimes up to fever heat, and at other times down to zero, until the basin is pretty well filled with holes, to the number of from fifteen to twenty, and if from eight to ten holes have a fair thickness of coal, and an average of from twenty-five to sixty acres, it will be considered of ample proportions to do the next necessary thing—open out the mine, to an expense of from $25,000 to $60,000.

DISCUSSION OF MR. HOWELL'S PAPER.

Mr. Hanlon: I would like to ask Mr. Howells if a thickness of coal of four and a half feet is not unusual coming under a drift deposit?

Mr. Howells: I might say that it is not very often, but it has been found in several places. I can think probably of three or four or five places where coal of that thickness is found with nothing but drift on top. I think that it might be said that it is often found.

Mr. E. D. Haseltine: I wish to say a word in regard to the engineer's help in the locating of the basin of coal after the drilling has proceeded. The first thing we do in Mahoning county is to ascertain the probable course of the swamp and the lowest coal.

Mr. Brown: I would like to ask some questions about the method of finding coal by the use of a branch or witch hazel. I have heard that such methods have been used, and about the accuracy with which it has been done, as to the location and thickness of the coal, etc.

Mr. E. D. Haseltine: Mr. Brown has perhaps heard of Mr. Lattimer. But my experience is that Mr. Lattimer only located one mine by the use of the stick, which was in a very large field of excellent quality. After they had worked it a few years I made a survey and map, and afterwards I found on the map where the swamp extended, where he had mapped out the course of the coal quite accurately, but I regret to say that when we came to that part of the mine there was no coal there at all. The breadth of the coal was not more than fifteen yards, and the other way on each side of that there was a great field of coal.

Lattimer was testing once in the Mahoning Valley. He was taken to a mine where the coal was all taken out, and he got his witch hazel out, and said there is lots of coal there. If he had said there had been lots of coal there he would have been all right.

Mr. Peters: As to the duty of an engineer with regard to drilling holes, I think the work of the mining engineer should precede the drilling to a very large extent. Mr. Howells spoke about bringing into use the knowledge of the miner and the driller. Well, if a miner is one that has followed the vocation of digging coal all his life without extending his knowledge in geology, at least somewhat, in regard to that particular locality, I think his knowledge is not quite what is wanted, and so far as the driller's knowledge is concerned, unless it is pretty extensive, that might be very much lacking. I know of some localities, particularly in the Sunday Creek Valley, where the Bayley Run vein was drilled for, where the surface of the valley was above the ele-

vation of the coal; but at one time, very evidently, the creek had run all over that valley, and to my mind had, at different times, occupied lower levels than that it now occupies, as well as different places throughout the valley from foot of hill to foot of hill, and in course of time had washed out that coal, and the drillers who drilled in different places along that valley pronounced that there was no coal in that vein, and condemned it; whereas, if they had gone up the hill a piece they could have found it, as it has been found since. There are a few localities where coal has not yet been found, but I do not think it has been investigated properly.

Mr. E. D. Haseltine: The gentleman's remarks are, no doubt, applicable to the Hocking Valley, but in the Mahoning Valley any practical inspection as to the probable locality of coal would be absolutely worthless. The way to find it is to drill.

Mr. Peters: I meant to say that if an engineer were called in at the proper time, he could take these things into consideration. If there is no rule to go by, he is the one who, by reason of his extended experience, could determine that better than almost any person else, and if he has not any means by which he can tell he can come as near guessing it as anybody else, and if he has a method of determining where to look, he is the one to consult.

Mr. E. D. Haseltine: That is the reason why I think the driller should go ahead. The engineer may not have that long experience and judgment which the practical driller has.

Mr. Peters: If the engineer thinks the driller should go ahead, let him go ahead. The engineer is the one to determine who should go ahead.

Mr. Haseltine: The man who puts his money in is the one to determine that.

Mr. Howells: What I said in my paper referred to the No. 1 vein, and the condition of things is so different in those districts from other parts of the State, that engineering and surveying up in that country without a practical knowledge would be worthless. In other words, the engineer or surveyor would not know anything about it, unless he had a practical knowledge of that field. I said in my paper that the man, in my opinion, should be a miner; I did not mean by that, a coal digger. I meant a man conversant with mining, and who knew geologically all about the formation in that part of the State. A man might know nothing at all about some other part of the State and yet be familiar with that locality. When you come to places where the coal veins are persistent and regular, certainly then the engineer is away ahead of any practical experience, because he has the theory and practice; but in the No. 1 vein of coal, unless he has had a thorough, practical knowledge and training, his knowledge as an engineer does not amount to a snap of a finger. Now,

have had engineers, at least one, to positively tell me that coal could be found below that No. 1 vein, and some of the parties here present knew where he meant, perhaps. He would persist that the Bridgeport coal was under the No. 1 vein, and would persist in drilling holes down below that. Now, we have had men up there in that country, who went to work and put holes down and drilled below where the coal ought to be—drilled down some 300 feet below, or 400 feet, drilled away below where the coal should be. Now then, there's where the practical knowledge of the locality comes in. It is not because he happens to know more than some one else, but because he happens to know more about that part of the country, because he has had experience there; just like the Swiss who knows more about his native mountains than a man who has never been there before. He has paid for his experience; he has spent fortunes in finding this experience out. The conditions are such up there that no one knows exactly where to drill. It is a fact, as I say there, that some tenderfeet have found some of the finest basins in the No. 1 vein of coal; and I will refer to one which you have all heard of doubtless, and probably the greatest basin of coal found in the Upper vein, that is the old Churchill mine, it was a tenderfoot that found that—a doctor. He owned a farm and did not know anything about coal mining.

The experience that a person gets in his locality is the best. He becomes so familiar with the material that he can tell, to a certain degree at least, if not positively, whether that material is above or below the coal. The material changes a good deal and differs a good deal. Mr. Hanlon is from my country, but I doubt very much whether he could tell where the belt of the No. 1 coal extends as well as I can. Yet, being an engineer, in that part of the country he can tell better than engineers from some other part of the State. The land looks the same on top. I remember of traveling with a friend on the cars once, and we were sleeping and woke up, and he looked out of the window and said, "Now, that is mighty nice coal country; there is coal there, sure." It was miles and miles from where the coal was. I have seen men travel over land, and say, "Well, now, this looks pretty well; there ought to be coal here." It is more so in our part of the State than in other parts of the State. It requires practical experience and not theoretical knowledge to find coal there.

Mr. Peters: I do not know whether I ought to accuse Brother Howells of looking upon mining engineers as being fastened to the instrument, or not. Now there are a good many people who look upon a mining engineer as though anything they know outside of what they can find out by having an instrument fastened to them, does not amount to anything, and do not consider that as his legitimate business. I look upon experi-

ence and observation, and study of the formation of the measures that are developed by the drill, as being a part of the education of the mining engineer. He will acquire in course of time, by observation, that knowledge which the practical driller will acquire, and he will have that knowledge based upon a prior knowledge of the principles of Geology, and if any of those measures are persistent he will know it, and he will know how much to depend upon it. If they are irregular and come in at hap-hazard, he will know that, and in course of time he will have acquired a store of information that will be invaluable, and be well worth paying for. There are things that if we know are entirely absent, that knowledge is just as valuable as though we knew it existed in large quantities. I have known men who invested a large amount of money in land, who, if they had known the conditions which could have been found out by employing an experienced mining engineer, would have saved thousands of dollars; but they went ahead and bought property and invested money, and the first time they thought they had any use for an engineer was when they had some mechanical surveying to do. If people, who are about to invest in coal land, would say to the mining engineer, "I want to know what you know about it, and if you do not know, I want you to find out," it is possible that would be the best investment to make. It is possible, too, there are characteristics about that country that mining engineers would know, and the operators and drillers do not know.

Mr. Howells: I do not want Mr. Peters to understand that I detract anything from mining engineering. I would that I was more efficient in it than I am. But in my paper there, I say that, in my opinion, I think it is necessary to be a practical miner. Now, if a mining engineer has that practical knowledge, why certainly he is a better man than if he is not a mining engineer; but if he has not that practical knowledge, but is merely a mining engineer, then I say his knowledge is worthless only as to engineering. Now, as my friend from the Mahoning Valley says, and I believe Mr. Hanlon, as an engineer, would carry me out in that, that when the engineer is first required up in that country, is when you have located your basin of coal with the drill holes, and you want to find out how much acreage of coal you have, in order to know whether you can afford to expend the necessary amount of money to open a mine. Another reason is to level it up, so as to get as near as possible to the lowest part of the basin to open your mine, to run your switches, etc. Now, then, that is about the first time that they expect to call upon an engineer in that country. Where the strata is persistent, a mining engineer can do much more than one who has gained his knowledge as a practical miner, because the mining engineer has more or less knowledge of Geology, or ought to have. The great point in that country is to under-

stand and know the fact as to whether the material you are drilling is above the coal or whether it is below. I know one place where the drill hole is drilled through what was afterwards known as the mountain mine; had drilled thirty feet through the coal. They sunk a shaft near there, and afterwards they came right straight against the drill hole, right through the coal and some thirty feet below it. Now, it is evident that these parties that drilled the hole, and one was considered to be a coal miner, drilled a hole through four and a half feet of coal without knowing it, and it is evident that the parties who drilled that did not know the difference between the strata below the coal and that above the coal. Hence it becomes, as I said, necessary to have full knowledge and acquaintance with the material that is above the coal, and the material below the coal. There is where the difference between knowledge, and the want of knowledge, comes in in that part of the country.

Mr. Peters: In order to understand the difference between Mr. Howells and myself, I think I can sum it up in a word, by saying that all drillers are not mining engineers, and all miners are not mining engineers; but all mining engineers are practical drillers, and all mining engineers are practical miners. I do not mean so far as manual labor is concerned, but so far as a knowledge of the business is concerned. I have in mind a property that any mining engineer, who is a mining engineer, who, by reason of his profession would necessarily have to know more or less about Geology, could have given information that would have enabled the parties to have invested, I am told, $150,000 to a great deal better advantage. This occurred in the Hocking Valley, where the strata are more persistent than in the Mahoning Valley. I understand, of course, the difficulty there is up in the Mahoning Valley and other valleys that Mr. Howells speaks of, but I think that mining engineers could be used to a great deal of advantage in place of practical drillers, so-called, and practical miners, so-called. If they are honest and conscientious in the execution of their duties, and want to build up the profession, they will not say to a man that they know, when they do not know. That is the situation in which I wish to see the mining engineers placed.

Mr. E. D. Haseltine: To come back to the first question as to the preliminary work of the engineer. If I, or any other engineer, was taken out on a farm in the Mahoning Valley to look at the surface and asked by the land owner "Is there coal under this farm?" the only thing you could conscientiously say is, that you did not know, and I do not think there is any difference between us about this, only that the differences are so great between that country and the southern part of the State. The conditions are entirely dissimilar. Mr. Howells has expressed it when he says it

is simply a question of practical knowledge, and if the engineer has a knowledge of drilling then he is competent, but if he has not as much knowledge as the old, practical driller, then he is not so competent as the driller."

Mr. Brooks: I know but little about that section, but I think the practical knowledge of a miner would be far more valuable than the engineer's knowledge. The engineer would likely begin to theorize about it, and he would wander off, and not be as apt to strike the truth as the man who is not an engineer at all.

Mr. R. M. Haseltine: The mining engineer, the old miner, or the mining expert, or any of those classical fellows, are of no use under heaven in the Massillon region, the Mahoning Valley, or any place else, if they have not a set of tools and a spring pole and are ready for work, and all they know is what they find. It is nothing but a species of gambling, and when they talk about science, and knowledge, and mining engineers finding coal it is all moonshine and gammon, and they do not know anything about it. Any man who is familiar with the strata stands just as good a chance of striking it rich as the old fellow who has grown gray in the service. Now, talk about long experince making men perfect. Well, that is true, as a rule, the world over. Speaking of reminiscences of drilling which Mr. Howells has opened up, he is playing right into my hands. I know of many cases, but one in particular, that came to my mind, which occurred at Churchill. The company was going to sink an air shaft and employed the oldest driller in the Western Reserve. A place was located for him. We knew about how deep it was to the coal and we drilled down ten or twelve feet deeper than we knew the coal was, and said there was no coal there; it was a mistake. We went inside of the mine and we could hear him drilling. We took a couple of miners in and dug in and struck his tools, and he would not believe that he had drilled through the coal until he sent his son around and he hallooed up to him through the hole.

There was a mining expert, Mr. Hollenback, of Churchill, (Mr. Howells knows him), who was probably the most successful man in all that country in finding basins. I know any quantity of places. At the Kline bank I remember of their being surprised at their entry coming in the vicinity of a place where they had found four and a half feet of black mud. The entry run so close to it, that for curiosity they cut into it, and there was four and a half feet of as nice coal as the world ever saw, and all they got out of it was black mud, and that man had had twenty years' experience. Now, when you come to talk about science and knowledge, the whole thing boils right down to this, and it does not make any difference whether he is an operator ar not: If in drilling you find the superincumbent measures in their natural order, of uniform thickness and everything in position as it should

be, why, it does not matter whether you strike the coal the first hole, or second, or not. It is good territory and you can chance your money on it and you will eventually strike it. But if you strike the coal under peculiar formation, and strike it three times out of five, it is a bad venture and a big gambling operation to open it up, for you will find something is wrong. The coal will not be of any practical value, or the formation will be such that it can not be mined, or something of that kind. If you find the coal of unusual thickness, look out, there is trouble right there, close by. Every mining engineer knows that, who has had experience enough to find it out. Every operator knows it, for he paid for finding it out.

Mr. Howells: My friend Haseltine calls it a gambling operation; I must differ with him there. Inexperienced men have found some of the finest basins of coal, men who did not know anything about drilling, but just went at it as a piece of gambling, but still, as I say in my paper there, that the same class of men have spent an enormous amount of money unnecessarily in trying to find coal. There is a difference between the strata above the coal, which gray slate or gray rock, and the conglomerate beneath. Now, sometimes they resemble each other very closely, and it takes a man of experience of years and years to determine the difference. Now, I have known several drill holes to go away below where the coal ought to be, and any one experienced in the matter would have known it. I claim that no experienced man, who has had years of experience, whether as a driller, or whether he has paid others for drilling, will go through a foot of coal without knowing it. As I said before my friend came in, I know of several places where they have gone through four and a half feet or five feet of coal without knowing it. The coal drillings get mixed up with the mud, and you pump it out and do not notice it. I think that is the reason why they have gone through the coal without knowing it. The difficulty is in not keeping the hole clean. If the rock is hard, you can keep the hole clean, but where the rock is not, it forms a paste, and if you drill four or five feet without pumping it, and you reach the coal, it gets mixed up with it, and you think there is no coal there, and I think that is the principal reason why the coal is not found.

Mr. R. M. Haseltine: Before you sit down let me ask you a question. In buying a coal territory already drilled, what elements do you place the greatest confidence in ? That is, what is the first question to which your mind is directed as to its value ? Is it the uniformity and thickness of the slates and gray rock that lies above the coal, or is it the thickness of the coal itself that you would place your greatest confidence in ?

Mr. Howells: I would place at least as much confidence in the strata above the coal as in the thickness of the coal. I say

in my paper there something on that point. You are more likely to find coal under a gray rock, that is from sixteen to twenty-four feet thick, than of any other thickness.

Mr. Haseltine: Now, suppose you had a hundred acres, and on it twenty drill holes, fifteen of which found coal under sixteen to twenty feet of gray rock, and the coal in it was only reported at four or four and a half feet ; and suppose you had another with an equal number of holes precisely similar, but where the rock was sometimes forty feet thick, and in others five or ten or fifteen feet thick, and the coal was five and a half feet and six feet thick, which territory would you select as the one you wanted to buy ?

Mr. Howells: The one I wanted to buy would be the one that had the gray rock more uniform. I refer to that in my paper. When the doal becomes of unusual thickness, seven feet or over, you should look out for some trouble in the matter.